companied by a simultaneous increase in the absolute amount of the charge; at an altitude of 3 kilometers we have a charge of more than 4 electrostatic units per cubic meter. For example on the basis of the Elster-Geitel determinations of the electrical charges in the atmospheric precipitation, V. Conrad (Wiener Berichte, 111, Abth. IIa. p. 342, 1902.) has computed that the amount of electricity in 1 gram of the water of a cumulus cloud amounts to 1/36 of 10^{-8} of a coulomb. Within a dense cloud in which the vision could penetrate to a distance of only 18 meters, there was according to Conrad's measurement 5 grams of water per cubic meter, consequently an electric charge of about 1/7 of 10^{-8} of a coulomb per gram of water. Now if the above-mentioned value of 4 electrostatic units, or 4/3 of $10^{-9} = 4/30$ of 10^{-8} of a coulomb of negative electricity be assumed as the charge per cubic meter, then even this amount of electricity would suffice to explain quantitatively the observed electricity of precipitation.

In general the process of condensation brings down only a small fraction of the electrons present. Suppose now that we consider that only the negative electrons take part in the precipitation, then these are weighted down by coatings of water and sink down as rain, but according to our measurements about an equal quantity of positive electricity per cubic meter remains behind in the cloud. Now as Conrad has already shown, if, for instance, we suppose a cumulus cloud of spherical form of only 1 kilometer radius to rest with its center 3 kilometers from the earth's surface, then it will by its own internal charge cause a decrease of potential at the earth's surface of about 11,000 volts per meter of vertical distance. Now, such values have been actually observed in thunderstorms at the earth's surface. If we reflect that for such a gradient a point in the air of 500 meters above the earth would show a difference of tension of 5,500,000 volts with respect to the earth, then we find ourselves here brought to consider tensions such as we see relieved by the mightiest electric process of the atmosphere, i. e., the thunderstorm. As early as 1887 Lins[3] had calculated the immense electrical forces called into being when the charges assumed by him to exist in a cloud, were separated by great stretches of space, and showed that sources of energy were here revealed to us, which were more than sufficient to explain the most violent phenomena of thunderstorms. The theory of electrons now gives us, as we have shown, a surprisingly simple explanation of these charges, and our electron traps deliver to us catches whose magnitudes are quite sufficient to explain the phenomena in a quantitative way. And now finally the last problem, the one which offered altogether insurmountable difficulties to all the old theories, begins to gradually become resolvable from the standpoint of the new theory, viz, the problem of the permanent charge of the earth and the existence above it of a field of electrical tension, or the so-called "fine weather electricity."

It was clear even to the earlier observers that the earth's surface always possessed an electric charge relative to the atmosphere, even in typical fine weather, when there was no trace of thunderstorm conditions within a considerable radius. At such times the earth's mass showed itself negatively charged as compared with the surrounding air; only during cloudy, rainy weather inclining to thunderstorm formation, would the sign of the earth's charge occasinally reverse, but even then only for short periods. To explain this electric charge proper to the earth itself the most divergent theories have been suggested, but none of them have been proved satisfactory. The properties of the electrons furnish a wholly new point of view from which the problem appears surprisingly simple. The positive and negative electrons are to be distinguished from one another wherever they occur by the different velocities at which they travel. Under the impulse of a given electrical force the negative electrons are more easily set in motion and *they travel much faster than the positive electrons*, which seem to be loaded with a greater quantity of inert matter. On the other hand both positive and negative electrons seem to be charged with the same quantities of electricity, which are distinguishable from each other only by their opposite signs. Now if such an electrical particle pass near a conducting surface, such as the earth's surface or that of some conductor in electric contact with the same, then the passing particle induces in the conducting surface a superficial charge of the opposite sign, which attracts the particle to it. This attracting force, which is directly proportional to the square of the charge and inversely proportional to the square of the distance of the particle from the conducting surface, influences both species of electrons in the same way, but the negative are able to respond to the electrical forces more easily and quickly than the positive. Thus, during a unit of time and with equal charges of positive and negative electrons in the air, a larger number of negative than of positive electrons will always reach the conducting surfaces and give up their charges to them. On mountains, tree tops, and similar places this process is of subordinate importance, since on these projections the charges of the negative earth repel the negative electrons and collect, as we have seen above, a preponderating number of positive electrons. There are, however, many spots on the earth's surface where its own charge is without effect in reference to the particles in the air and where, therefore, the inflow of negative electricity can proceed undisturbed. As Elster and Geitel have shown these places are all concavities, particularly those occurring under the leafy roof of the earth's vegetation, which are of the greatest extent, but also the cavities formed by caves, chasms, and fissures. In the latter cases the projecting portions and points form a very perfect electrostatic protection against the electrical field of the earth, which otherwise would hinder the wandering of electricity into the charged ground. We have evidences that the vegetation in particular plays a very important part in the atmospheric electric processes, and that the process above explained is quantitatively sufficient to renew the electric charge of the earth in the manner just described. It is certain that such a renewal of the earth's charge must occur, since the air is not a perfect electric insulator, and the conductivity due to the wandering of the electrons causes a perpetual tendency to equalization of the earth's charge and of the gradient of tension in the atmosphere.

There is still much to be said on the subject of the relation of this latter gradient to the conductivity of the air and the charge of electrons, and there is already a rather extensive collection of observations at hand which opens a series of new and interesting perspectives. A further consideration of this subject on this occasion would lead us too far; but we may rejoice in the fact that in the theory of electrons the processes of atmospheric electricity have acquired a point of view that promises to contribute very much to the solution of problems, some of which are centuries old, and that incites us to the most zealous pursuit of further studies in this much contested field of research.

ABNORMAL VARIATIONS IN INSOLATION.

By Mr. H. H. KIMBALL, Assistant Editor, dated April 15, 1903.

In the Comptes Rendus, Paris, March 16, 1903. Volume CXXXVI, pp. 713–715, Monsieur Henri Dufour announced that his observations with a Crova actinometer at Lausanne, Switzerland, indicated a diminution in the amount of solar radiation received at the surface of the earth at that place (latitude 46° 33′) in January, February, and March of the present year, as compared with the average of corresponding months for previous years. This is shown in the following table:

[3] See Pellat translated by A. G. McAdie, American Meteorological Journal September, 1885, Vol. II, pp. 215–221, and Park Morrill at pp. 438–445 of the same volume.—ED.

Average solar radiation at noon at Lausanne, Switzerland, in gram-calories per square centimeter per minute.

Month.	1897-1902.	1903.	Difference.
January	0.79	0.68	0.11
February	0.86	0.71	0.15
March	0.89	0.70	0.19

M. Dufour is inclined to attribute this deficiency to the presence of large quantities of volcanic dust in the air as the result of the eruptions of last year in the West Indies.

It is evident that the solar radiation of M. Dufour is the radiation from the sun, as received by us on the earth, after it has been diminished by the very appreciable losses due to absorption and other atmospheric influences. This insolation, as actually measured by physicists, is expressed in gram-calories per square centimeter per minute. It has regular diurnal and annual variations but the abnormal variations are those that we are now considering.

Observations of insolation were made by me for the United States Weather Bureau with an Ångström electrical compensation pyrheliometer, from November 10, 1902, to March 26, 1903, at Asheville and Black Mountain, N. C., at an elevation of about 2200 feet and a latitude of about 35° 36′. There are no previous observations at these points with which to compare results, but it was noted at the time and was the occasion of comment, that the measurements did not increase after December as much as had been expected. The following are the monthly averages for the dates of observation, at noon, in gram-calories per centimeter per minute:

Year and month.	Asheville.		Black Mountain.	
	Insolation.	Mean altitude of sun.	Insolation.	Mean altitude of sun.
1902.		°		°
November	1.093	36.2		
December	0.948	31.2		
1903.				
January	0.832	33.2		
February 1-14	0.985	39.3		
February 19-March 26			0.986	47.8

The complete record will be published as a bulletin of the Weather Bureau.

Observations with a Crova actinometer have been continued for many years at Montpellier, France; in the MONTHLY WEATHER REVIEW for April, 1902, Vol. XXX, p. 179, Mr. C. G. Abbot has attributed a marked depression for the years 1884–1886 in the curve of mean annual noon insolation to the presence of large quantities of volcanic dust in the air, due to the eruption of Krakatoa in 1883.

While these conclusions appear to be plausible, particularly in the case of the long-continued depression of 1884–1886, there are other causes that may have contributed to the diminished insolation noted in North Carolina this past winter. The atmospheric conditions and the movement of storms in the United States were abnormal, particularly during March, when an area of high barometer persistently remained off the North Atlantic coast, causing in North Carolina winds from the ocean, much cloudiness, and rain.

It is difficult to distinguish between cause and effect in this case. Was the apparent slowing up of the eastward movement of high areas due to diminished insolation, or was the diminished insolation due to increased absorption and reflection of the heat rays as they passed through the earth's atmosphere? If the latter, was the excessive absorption and reflection due to the presence of volcanic dust in unusual quantities, or to an unusual amount of aqueous vapor in the atmosphere, particularly in the upper strata, due perhaps to local anomalies in the atmospheric circulation?

There seems to be no reason why this latter explanation will not suffice for the observations made in this country when considered by themselves, but if the insolation was deficient over most of the Northern Hemisphere, and continued to be deficient for a period of several months, then some more general explanation must be sought for. If volcanic dust is the cause, no doubt it will manifest itself in other ways, as, for instance, by causing brilliant after glows following the usual sunset colors. Observations of insolation and of sunsets for the coming months should therefore have special interest for meteorologists.

The following monthly means of insolation observed with the Ångström apparatus at Washington, D. C., at noon on clear days during April, May, and June, 1893, are added as this note goes to press:

Solar radiation, in gram-calories per square centimeter per minute.

Month.	Number of days.	Insolation.
1903.		
April	7	1.024
May	9	1.022
June	4	0.952

HAILSTORMS IN PORTO RICO.

By Mr. W. H. ALEXANDER, Observer Weather Bureau, dated April 30, 1903.

Hailstorms are so rare in Porto Rico that the impression seems to be quite general even among Porto Ricans that they never occur. This is a mistake as was recently demonstrated. The change of season from winter to summer occurs about the middle of April and is, as a rule very marked, being characterized by unusually warm, sultry days, frequent thunderstorms, the setting in of the trades, and in a measure the beginning of the so-called rainy season. This year was no exception unless it be in the unusual strength with which the trades have set in. The records show that from the 11th to the 14th thunderstorms were quite general over the island. The only important, because unusual, feature of the season worthy of special mention was the occurrence of a heavy precipitation of hail on the 12th instant in the vicinity of Caguas. Thinking a report of this might be of interest, effort has been made to secure as full and accurate information relative thereto as possible. Two intelligent gentlemen, one an American and the other a Porto Rican, who were eyewitnesses of the event have been interviewed, and their reports are fully reliable and confirm other information obtained from other sources.

The forenoon of Sunday, April 12, 1903, was warm and sultry, very favorable for the development of thunderstorms. It appears that the storm now under consideration had its beginning about 2 p. m. in the neighborhood of Aguas Buenas, moved eastward along and down the valley of the Bairo River, across the Loiza, and up the valley of the Gurabo. The storm was accompanied by some lightning and thunder and very violent winds, rendered more violent and destructive, no doubt, by the peculiar topography along the storm's track. Some small huts were overturned and considerable damage done to the uncut tobacco along the valley of the Bairo River.

Hail was first observed at Aguas Buenas where, as reported by Mr. Bowser, the fall was light, lasting about ten or twelve minutes, but farther down the river the fall was so heavy that the river bed was "white as snow," so thick were the hailstones. The track of the storm appears to have been just north of Caguas, although hail fell there for about fifteen minutes according to Dr. Lugoviño, who was in the city at the time. The precipitation of hail continued as far as Gurabo, but how much farther is not known.

As to the size and form of the hailstones, there are several